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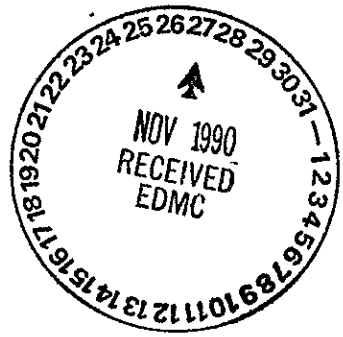
7. Abstract

The Pneumatic Needle Scaler was feature tested to determine if it could be used for wall/floor cleaning or dislodging of wastes in the single-shell tanks. The scaler has proven itselt an effective method of dislodging waste and cleaning tank walls. This technology will be recommended to be developed in the future.



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FEATURE TEST OF THE PNEUMATIC NEEDLE SCALER

K. G. Squires

September 1990

CONTENTS

1.0 INTRODUCTION

The feature testing of a pneumatic needle scaler was one of several tests called for by the *Single-Shell Tank Waste Retrieval Feature Test Plan* (Thompson 1990). The feature testing was conducted July 31, 1990, at the Chemical Engineering Laboratory in the 200 Area of the Hanford Site. Remote Systems Engineering conducted the testing with the assistance of the Chemical Engineering Laboratory personnel.

The objective of the feature testing program is to complement the *Single-Shell Tank Waste Retrieval Study* (Krieg, et al. 1990) in recommending technologies for further development as part of the *Hanford Federal Facility Agreement and Consent Order*, known as the Tri-Party Agreement (Ecology et al. 1989) Milestone M-06-00. The pneumatic needle scaler feature test was to evaluate "off-the-shelf" technology for waste dislodging. The scaler is envisioned as an end effector that would pulverize solid waste material and mix up the non solid waste materials. The scaler was tried on a number of different materials to evaluate its capabilities.

2.0 DESCRIPTION OF TEST

The pneumatic needle scaler is a production item with the following specifications:

Brand Name:	Jet[1]
Model/Item:	F-25NS Flux Chipper/Needle Scaler Combination
Serial #:	010447
Length:	16.375"
Weight:	5.25 lbs
Operating Pressure:	90 psi
CFM:	4 cfm
Blows per Minute:	4000

The Jet F-25NS needle scaler has 19 replaceable scaling needles. (Appendix A)

The pneumatic needle scaler is an air driven piston which the scaler needles are attached to (see Appendix A). As the piston cycles the scaler needles move up and down impacting the material applying a force which could dislodge material or clean/polish the surface.

1. Jet is a Trademark of Jet Equipment, Japan

3.0 TEST METHOD AND TEST EQUIPMENT

During the course of testing, the scaler was applied to the surface of several saltcake and sludge simulants. These were:

Sodium Nitrate/Nitrite Saltcake Simulant
Sulfur (K)-mag Saltcake Simulant
Bentonite Clay Sludge Simulant
Carbon Steel
Masonry Block

The saltcake simulants and the masonry block cover the range of real saltcake waste which varies from a crust with a soft material underneath to near concrete. The sludge simulant is what is expected to be the thickest wet sludge waste.

The pneumatic needle scaler was originally designed for removing weld stresses and chipping away slag from arc welds. This tool was applied to the surface of the waste simulants in the similar manner, but for a different application. The scaler was traversed horizontally across the surface of the simulants to investigate its ability to dislodge waste. The scope of much of these tests is to investigate the function of the scaler qualitatively.

The sodium nitrate/nitrite saltcake simulant was dried into 18 gauge stainless steel pans to an approximate thickness of 1/2 in. - 3/4 in. The pans were weighed before testing began. After a timed traverse the pan was to be weighed again to quantify the amount of material removed. The length, width, and depth of the traverse were also measured for a comparison of the material removed.

The same method was followed with the sulfur (K)-mag saltcake simulant. A timed traverse was measured for material removal by two different approaches: Approximate volume, and before-and-after weight comparisons.

The scaler was submerged into bentonite clay sludge simulant to test its operation. The pins were forced completely into the sludge so that the sludge was packed into the pin housing and the piston spring. This was done to determine the operability of the scaler in adverse conditions.

The scaler was run on the rusty surface of a piece of carbon steel. This was done to observe the effect scaling might have on the liner of the single shell tanks. The scaler was also run on the surface of a masonry block to test its durability under extreme conditions.

4.0 TEST RESULTS

The test data is located in Appendix B.

4.1 SODIUM NITRATE/NITRITE SALTCAKE SIMULANT

During the execution of the scaler test, one unplanned event occurred. The sodium nitrate/nitrite simulant in the stainless steel pans was not bonded to the pans as previously thought. The scaler, which operates at 4000 blow per minute, was sufficient to vibrate the majority of the simulant from the pan and cause data collection for this portion of the test to be impossible.

Although removal could not be quantified, the scaler was effective at disintegrating the material. The sodium compounds were crushed into a fine powder by the scaling pins. Removal was much more rapid than the Sulfur (K)-mag saltcake simulant.

4.2 SULFUR (K)-Mag SALTCAKE SIMULANT

The testing on the sulfur (K)-mag saltcake simulant proved more productive than the sodium nitrate/nitrite. This simulant is comparable to a salt lick block in density and hardness. The material removed on a horizontal traverse averaged 1/4 in. deep. The average volume material removal was 4.0 $in.^3/min$ by measuring the volume using a tape measure. By comparing the weights of the simulant before and after scaling, the average removal rate was 5.7 $in.^3/min$.

The scaler was also tested for its ability to make vertical penetrations. The average depth for these penetrations was 0.8 in. The scaler was not effective beyond this depth. The wall of the hole created too much friction for the pins on the perimeter of the array to keep functioning; therefore, the penetration could go no further. The penetrations also necked down with depth. The total allowable scaling area when the pins are free floating is .785 $in.^2$ with maximum diameter of 1 in. The diameter of the penetrations was 5/8 in. The removal rate for the penetrations was 1.0 $in.^3/min$.

At the beginning of the vertical penetrations the material removed was blown to the sides of the scaling pins. As the depth of the hole increased much of the material removed was blown out of the hole through the space between the pins. The hole decreased in diameter as the depth increased. The pins were being forced together and the material had less room to escape. This, in conjunction with the increase in friction mentioned above, caused the penetration to stop.

4.3 BENTONITE CLAY SLUDGE SIMULANT

The scaler was tested with bentonite sludge simulant to observe its function with sludge on the pins. First, the pins were run on the surface of the sludge. Through a sort of capillary action the sludge migrated up the pins covering all of them. The sludge muffled the sound but did not affect the operation of the pins. Second, the scaler was submerged in the sludge forcing the sludge to pack the inside of the pin housing. The pneumatic piston continued to function but the action of the pins was dampened. The scaler still functioned to remove sulfur (K)-mag. Last, about 1 in. of sludge was spread on the surface of the sulfur (K)-mag. The scaler was tested to observe material removal of the block through the sludge. The pins on the perimeter of the array were slowed down because of the adhesive quality of the bentonite. The pins in the center of the array continued to remove material. As dust was formed from the sulfur (K)-mag saltcake simulant block it stuck to the bentonite clay sludge simulant and the sludge was less adhesive.

Overall, the bentonite clay sludge simulant reduced the efficiency of the scaler but did not affect its ability to function under such conditions.

4.4 STEEL/MASONRY

The scaler was tested on a piece of carbon steel. The rust on the steel was removed and the surface was polished. The scaler had no visible detrimental effects on the steel.

The scaler was run on the surface of the masonry block. The pins were unaffected by the block. The scaler only brazed the surface of the block.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The scaler proved to be an effective method for removing saltcake simulant from the tank liner. Its performance as a volumetric material remover was sufficient to warrant investigation of the method on a larger scale. The scabbler is recommended as the next step of development with the possibility of design modifications to better suit this particular application. A scabbler is a tool used to remove layers of concrete with pneumatic pistons and carbide tipped bits. It is on a larger scale than the scaler with each bit as large as the entire scaling area of the scaler.

6.0 DISPOSITION OF THE TEST ITEM

The Jet F-25NS Needle Scaler was left at the of Chemical Engineering Laboratory where the testing was performed and the equipment was originally procured.

7.0 REFERENCES

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Krieg, S. A., Jenkins, W. W., Leist, K. J., Squires, K. G., Thompson, J. F., 1990, *Single-Shell Tank Waste Retrieval Study*, WHC-EP-0352, Westinghouse Hanford Company, Richland, Washington.

Thompson, J. F., 1990, *Single-Shell Tank Waste Retrieval Test Plan*, WHC-SD-ER-TP-002, Westinghouse Hanford Company, Richland, Washington.

A P P E N D I X A

VENDOR INFORMATION

FLUX CHIPPERS/NEEDLE SCALERS/RIVET BUSTER

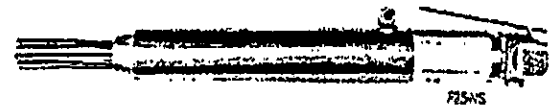
JET F-25 FLUX CHIPPER

- Heavy duty
- Optional needle scaler attachment (NS-25) mounts to convert unit to a needle scaler
- Ball lock retainer holds chisel safely
- Standard chisel included


F-25

JET F-25NS FLUX CHIPPER/NEEDLE SCALER COMBINATION

- Comes with chisel and scaler attachment
- Flux chipper becomes a needle scaler with 19 replaceable needles

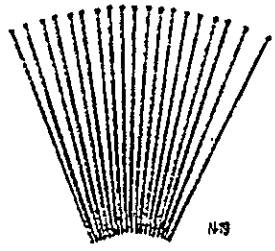

F25NS

JET FLUX CHIPPER & CHIPPER/NEEDLE SCALER COMBINATION

Model	Stock #	Bore & Stroke	Blows Per Minute	Overall Length	Avg. Air Consumption	Air Inlet	Air Hose	Recommended Air Pressure	Net Wt. (lbs.)	Ship Wt. (lbs.)
F-25	536725	1" x 7/8"	4,000	9¼"	4 CFM	¼" PT	¾"	90 PSI	3¾	4lb
F-25NS	536700	1" x 7/8"	4,000	15¾"	4 CFM	¼" PT	¾"	90 PSI	5¾	6

JET FLUX CHIPPER & CHIPPER/NEEDLE SCALER COMBINATION ACCESSORIES

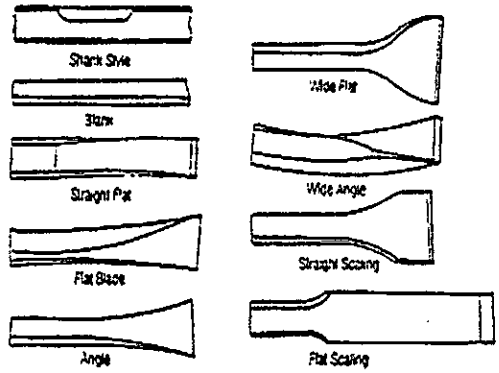
Model	Stock #	Description	Ship Wt. (lbs.)
N-19	530529	19 Needles	1
N-25	530577	Needle Scaler Attachment for F-25 or replacement needle for F-25NS	2


N-19

JET WELD FLUX SCALER CHISELS

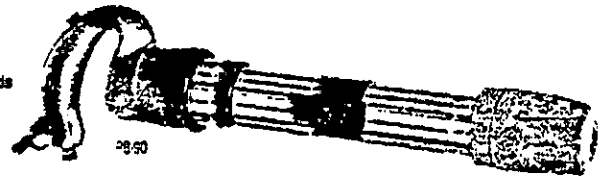
Model	Stock #	Overall Length	Blade Size	Net Wt. (lbs.)
BLANK (WITHOUT POINT)				
BC-1	530531	6¼"		½
STRAIGHT FLAT				
SFC-1	530532	6¼"		½
FLAT BLADE				
FBC-34	530533	6¼"	¾"	½
ANGLE				
AC-34	530534	6¼"	¾"	½
WIDE FLAT				
WFC-138	530535	6¼"	1⅜"	¾
WIDE ANGLE				
WAC-138	530536	6"	1⅜"	¾
STRAIGHT SCALING				
SSC-2	530537	6"	2"	¼
FLAT SCALING				
FSC-34	530538		¾"	¾

JET WELD FLUX SCALER CHISELS



JET RB-90 RIVET BUSTER

- Hard hitting, powerful hammer for cutting off bolt and rivet heads
- May be used for heavy chipping and nail driving
- Comes equipped with Arrow® retainer and retainer spring
- For standard 1" tooling


RB-90

JET RIVET BUSTER

Model	Stock #	Piston Diameter	Piston Stroke	Rivet Capacity	Impacts Per Minute	Overall Length	Recommended Air Pressure	Shank Size	Avg. Air Consumption	Air Inlet	Air Hose	Net Wt. (lbs.)	Ship Wt. (lbs.)
RB-90	550095	1¾"	3"	1¼"	950	20¼"	90 PSI	1"	38 CFM	¾" PT	¾"	23	25

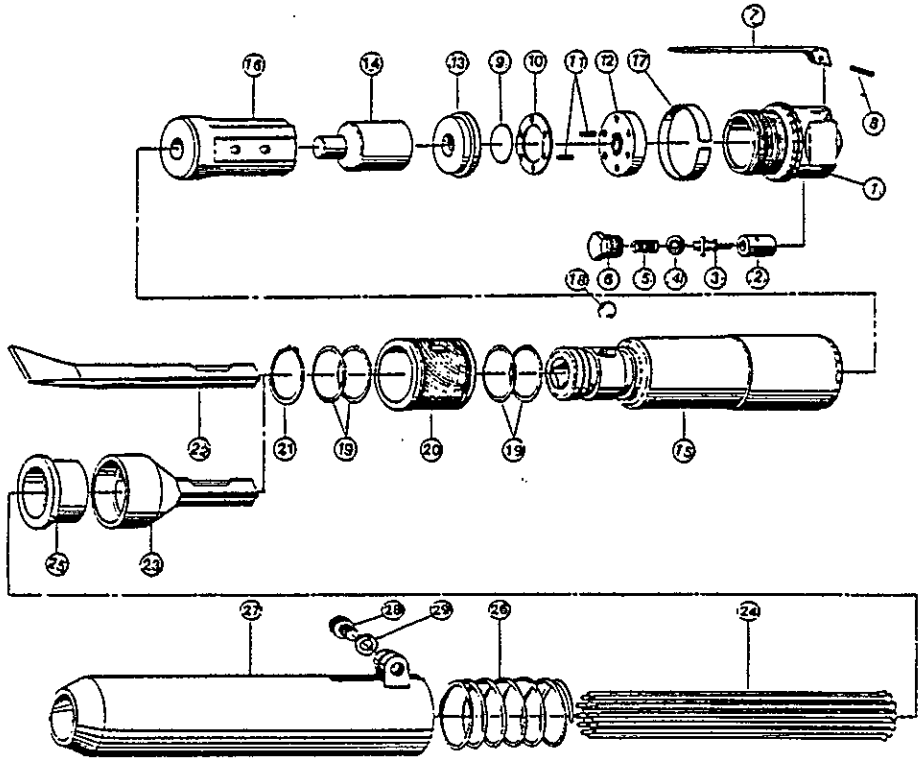
RIVET BUSTER ACCESSORIES

Model	Stock #	Description	Ship Wt. (lbs.)
JCR-118	550094	Kit converts RB-90 to 1⅛" includes 2 sleeves and 1 Rubber Bumper	1
RS-10	550098	Rivet Buster Retainer Springs, 10 pcs.	1
SR-90	550097	Standard Retainer	1


SR-90

MODEL: FLUX CHIPPERS
MODEL: NEEDLE SCALERS

• EXPLODED VIEW



• PARTS LIST

Index No.	Name of Parts	Per Set	Index No.	Name of Parts	Per Set	Index No.	Name of Parts	Per Set
1	Cylinder Cap	1	11	Upper Main Valve	1	21	Snap Ring (STW30)	1
2	Throttle Bushing	1	12	Lower Main Valve	1	22	Chisel	1
3	Throttle Rod	1	13	Pin (2.8×11)	2	23	Needle Shank	1
4	"O" Ring	1	14	Piston	1	24	Needle	19
5	Spring (8×16)	1	15	Cylinder Body	1	25	Needle Flange	1
6	Throttle Cap	1	16	Piston Sleeve	1	26	Spring (38×83)	1
7	Throttle Lever	1	17	Lock Ring	1	27	Needle Cover	1
8	Spring Roll Pin (3 · 22)	1	18	Ball (7/16)	4	28	Hexagon Socket Bolt (M8 × 20)	1
9	Main Valve	1	19	"O" Ring (P24)	1	29	Spring Wasner (M8-No.2)	1
10	Main Valve Case	1	20	Chisel Cover	1			

A P P E N D I X B

TEST DATA SHEETS

DATA SHEET

TEST ENGINEERS: DT Ruff

TEST ITEM: NEEDLE SCALER JET F-25NS

DATE: July 31, 1990

PIN MATERIAL: _____

SLUDGE VISCOSITY: _____

BLOWS/MINUTE: 4,000

SCALING AREA: 0.785 in^2

STROKE DISTANCE: .875 in

STEEL COMPOSITION: Low Carbon

SIMULANT DENSITY: 2.0 g/ml

SIMULANT COMPOSITION: Sulfur K-mag

SIMULANT DESCRIPTION: _____

TEST RUN NUMBER

	1	2	3
WEIGHT BEFORE (lbs)	42.47 lb	41.6	41.4
WEIGHT AFTER (lbs)	41.6	41.4	41.2
LENGTH OF TRAVERSE (in)	10.5	10	10
AVERAGE WIDTH OF TRAVERSE (in)	1.5 x 1/4"	.5 x 1/2"	1.5 x 3/8"
TOTAL TIME FOR TRAVERSE (sec)	67	57	47

DATA SHEET Page 2 of 10

NOTES AND OBSERVATIONS:

DATA SHEET

SIMULANT DENSITY: 2.0 g/ml

SIMULANT COMPOSITION: Sulfur (K) · mag

SIMULANT DESCRIPTION: It approximates the hardness of a salt lick block.

SIMULANT	TEST RUN NUMBER				
	1	2	3	4	5
WEIGHT BEFORE (lbs)					
WEIGHT AFTER (lbs)					
DEPTH OF TRAVERSE (in)	7/8"	3/4"	3/4"		
TOTAL TIME FOR TRAVERSE (sec)	30	30	30		

The diameter of each penetration was 5/8".

DATA SHEET

NOTES AND OBSERVATIONS:

THE SCALER TURNED THE SIMULANT INTO DUST AND GRANULAR FRAGMENTS.

DATA SHEET

SIMULANT DENSITY:_____

SIMULANT COMPOSITION: Sodium Nitrate / Nitrite

SIMULANT DESCRIPTION:_____

_____

	TEST RUN NUMBER		
	1	2	3
WEIGHT BEFORE (lbs)			
WEIGHT AFTER (lbs)			
LENGTH OF TRAVERSE (in)			
AVERAGE WIDTH OF TRAVERSE (in)			
TOTAL TIME FOR TRAVERSE (sec)			

DATA SHEET

NOTES AND OBSERVATIONS:

THE SCALER VIBRATED THE SIMULANT PINS SO MUCH THAT THE SALT CAKE SIMULANT BROKE UP AND FELL OUT OF THE PINS.

DATA SHEET

SIMULANT DENSITY: _____

SIMULANT COMPOSITION: Bentonite Sludge

SIMULANT DESCRIPTION: _____

_____

SIMULANT	TEST RUN NUMBER				
	1	2	3	4	5
WEIGHT BEFORE (lbs)					
WEIGHT AFTER (lbs)					
DEPTH OF TRAVERSE (in)					
TOTAL TIME FOR TRAVERSE (sec)					

DATA SHEET

NOTES AND OBSERVATIONS:

THE SLUDGE MIGRATED UP THROUGH THE PINS AND STUCK TO THEM. THE SCALER WAS SUBMERGED IN THE SLUDGE. IT KEPT FUNCTIONING.

DATA SHEET

COMMENTS ON THE AFFECT OF SLUDGE ON THE SCALER:

THE SLUDGE BUILDUP DID NOT EFFECT THE SCALERS OPERABILITY.

OBSERVATIONS OF THE SCALER IN SLUDGE AND SALT:

SLUDGE GATHERED AROUND SCALER PINS BUT STILL DISLODGED THE SALT.

DATA SHEET

OBSERVATIONS OF THE SCALER ON STEEL:

THE SCALER POLISHED THE CARBON STEEL AND REMOVED THE RUST.
IT LEFT NO VISIBLE EFFECTS ON THE INTEGRITY OF THE STEEL.
ALSO DID NOT DENT 18 GAUGE STAINLESS STEEL

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